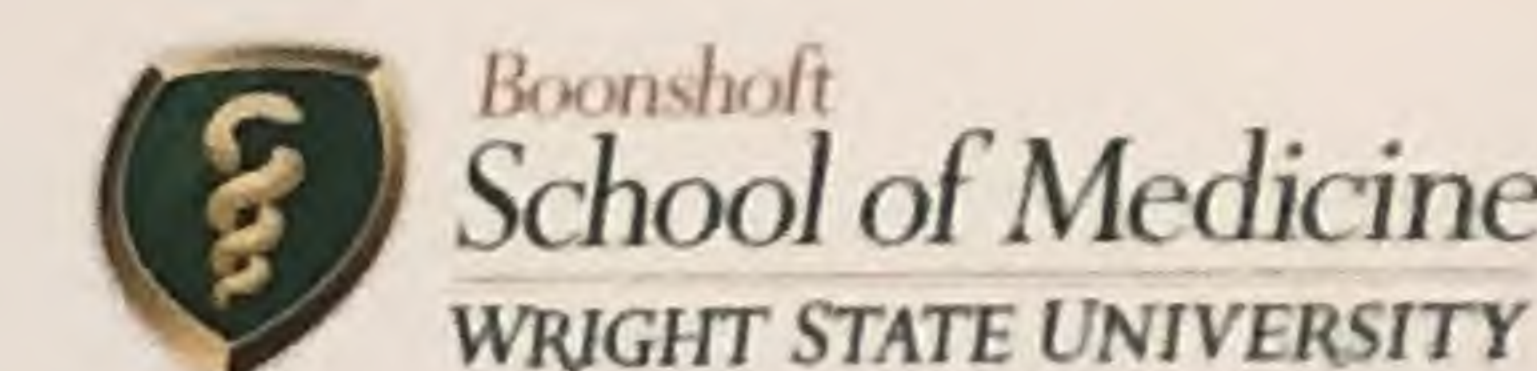


The Association of Perfluoroalkyl Substances and Renal Function in NHANES 2015–2016 Population

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Background

Perfluoroalkyl substances (PFASs) are manufactured compounds widely used in consumer products. These products include food packaging, cookware, textiles, fire-extinguishing foam, among others.¹ The U.S. National Health and Nutrition Examination Survey (NHANES) conducted in 2011–2012 detected PFAS compounds in serum of 97–100% of sampled individuals aged 12 years or older.²

Research suggests the renal system is a main site of PFAS metabolism, due to both storage and excretion of PFASs by the kidneys.³ There are growing concerns and evidence for adverse effects of PFASs on kidney function, yet many gaps in understanding exist.

Methods

A cross-sectional analysis of data from 1953 participants aged 12 or older from 2015–2016 National Health and Nutrition Examination Survey was completed. Five serum PFASs analytes were assessed including Perfluorooctanoic acid (n-PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (n-PFOS), and sum of perfluoromethylheptane sulfonate isomers (Sm-PFOS). Renal function was evaluated as serum creatinine. This study used de-identified data, therefore review by the IRB was not required.

Results

Figure 1 displays male and female median concentrations for each PFAS. Medians were larger for all five PFASs in males compared to females ($p < .001$). The highest concentration PFAS was found to be n-PFOS, with an overall median of 3.2 ng/mL.

In adjusted analysis for socio-demographics, and BMI, as compared to the lowest tertile of serum PFASs, the medium and high tertiles had a significantly increased risk of elevated serum creatinine levels for all five analytes in overall models.

The strongest association was seen for Sm-PFOS; medium tertile had 95% higher risk: 1.95(95% CI: 1.47 to 2.59, $p < .001$) and highest tertile had 149% higher risk: 2.49 (95% CI: 1.78 to 3.48, $p < .001$) of elevated serum creatinine, respectively.

Results

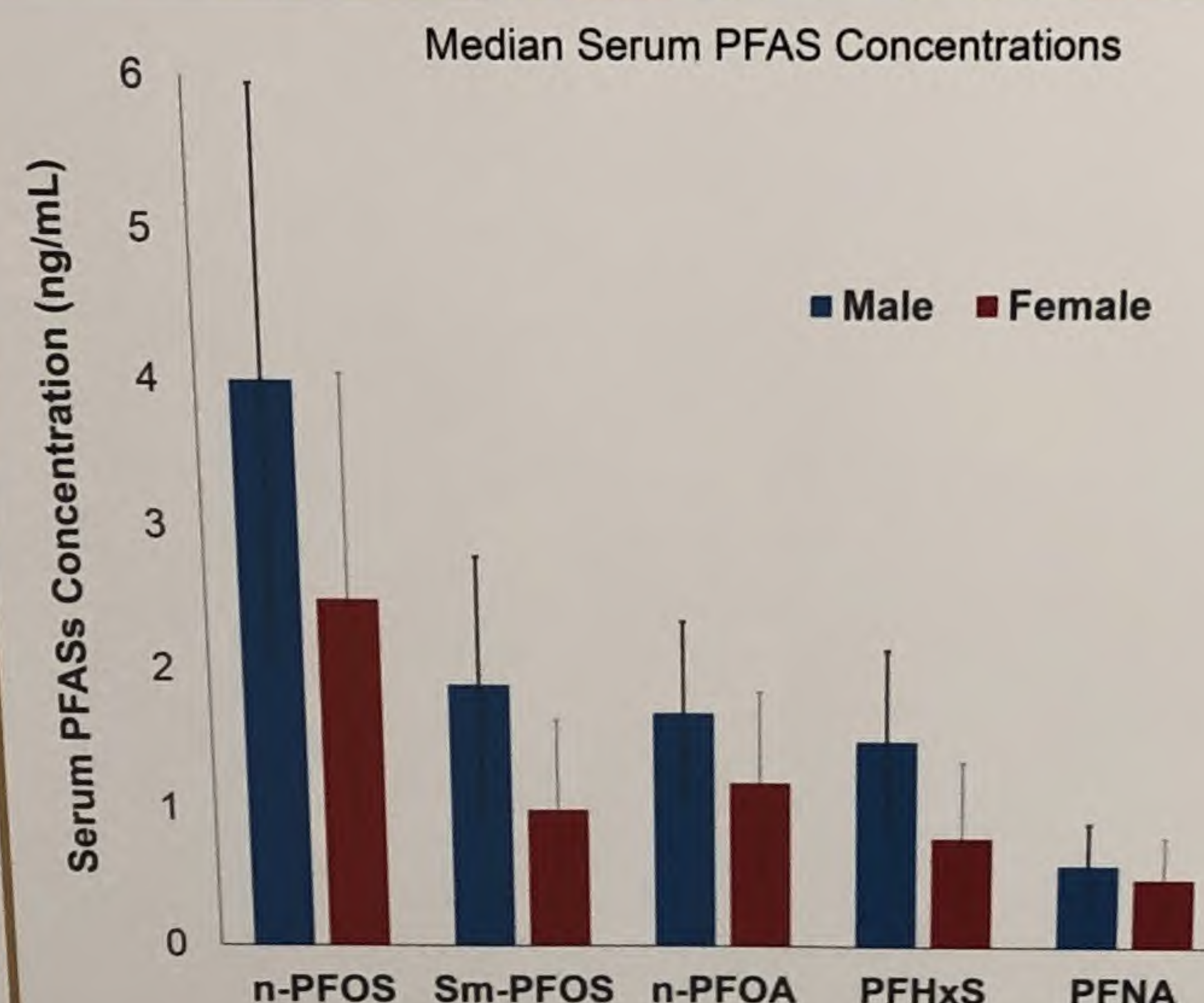


Figure 1. Median serum PFAS concentrations (ng/mL) with 95% CI with significant differences between males and females ($p < .001$).

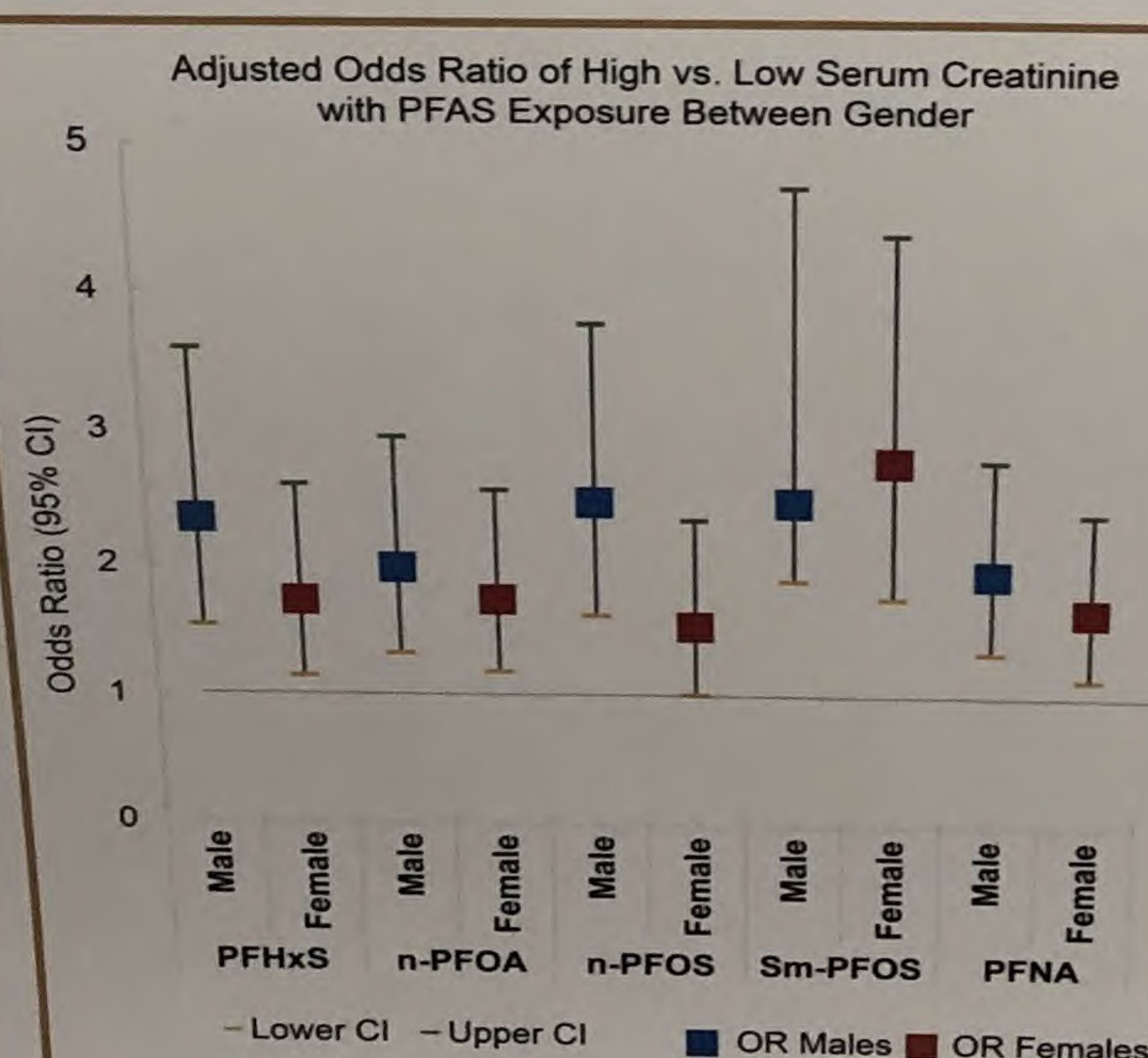


Figure 2. Adjusted odds ratios of high vs. low serum creatinine with PFAS exposure and 95% CI between males and females.

Results Continued

Figure 2 displays adjusted analysis results for males and females. Figure 2 demonstrates that in both men and women the association of significantly increased risk of elevated serum creatinine levels for all five analytes in overall models remains. The strongest association was seen for Sm-PFOS where the highest tertile had 198% and 177% higher risk of elevated serum creatinine respectively for men and women.

Further compared to the lowest respective tertile of serum PFASs, the medium tertiles of PFASs in males had a significantly increased risk of elevated serum creatinine levels in PFHxS, n-PFOS and for all analytes in females ($p < .001$ for all).

Discussion and Conclusion

Our results suggest PFASs are associated with reduced renal function in the healthy US population. These findings agree with previous research that has suggested the adverse effects of PFASs on renal function.

Our results suggest this relationship is unique between genders. Limited evidence from human and laboratory studies suggests that PFASs can impact renal function via toxicity on glomerular endothelial cells and oxidative stress in a sexually dimorphic manner.

In February 2019, the EPA announced their PFAS Action Plan to address PFAS and protect public health.

Future longitudinal studies can examine if expected declining US population PFAS exposure is reflected in renal function assessments.

References

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Perfluoroalkyl chemicals (PFAS) are persistent organic pollutants (POPs) that are found in many consumer products. PFAS are known to be persistent in the environment and in the human body. PFAS exposure has been associated with various adverse health effects, including increased risk of cancer, reproductive and developmental problems, and immune system dysfunction.

Participants

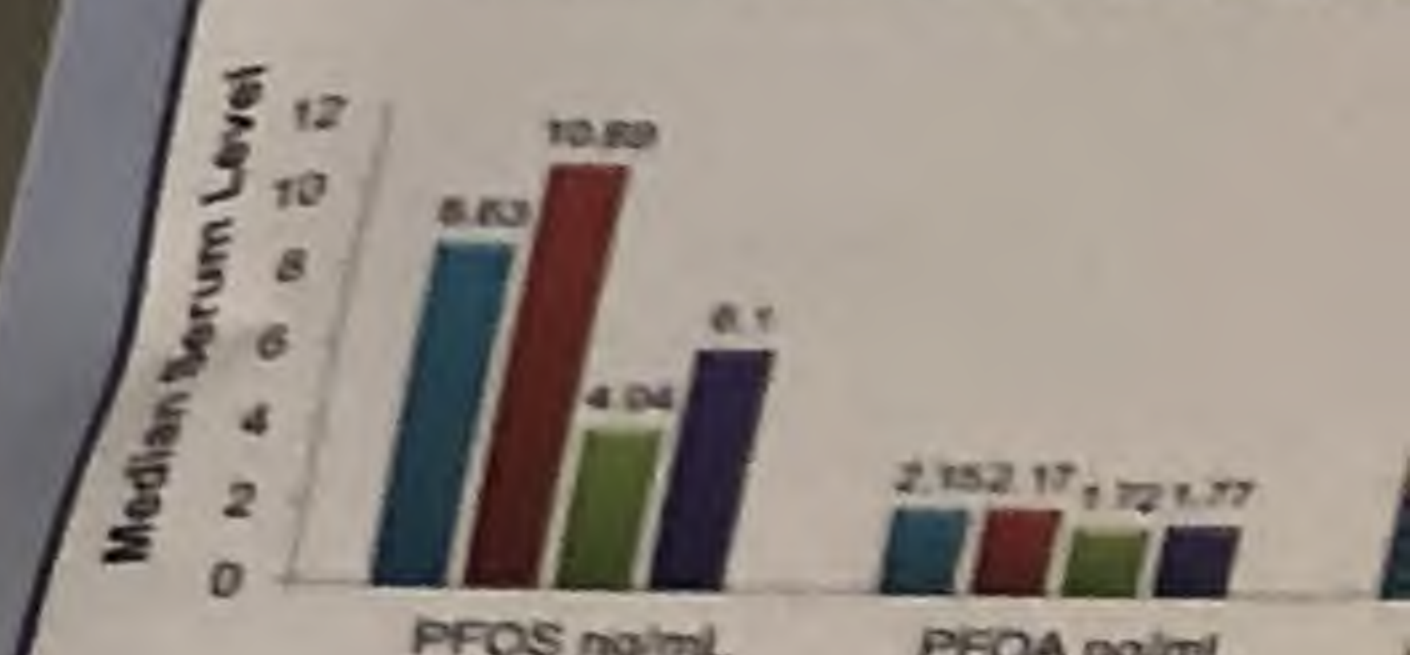
The cross-sectional analysis included 1953 participants aged 12 years and older from the 2015–2016 National Health and Nutrition Examination Survey (NHANES). The study population was representative of the US population. Participants were selected using a complex, multistage probability sampling design. The study included participants from all 50 states and the District of Columbia. The study excluded participants who were currently pregnant, had a history of kidney disease, or had a history of liver disease.

Statistical Analysis

Data were analyzed using R software. Descriptive statistics were calculated for all variables. The distribution of serum PFAS concentrations was assessed using histograms and density plots. The association between serum PFAS concentrations and serum creatinine levels was assessed using multivariable regression models. The models were adjusted for age, sex, race, education, income, BMI, and smoking status. The results were presented as adjusted odds ratios (OR) and 95% confidence intervals (CI).

Results

Figure 1. Median PFAS concentrations (ng/mL) and NHANES 2015–2016.



WP: Wright-Patterson